RESEARCH DEPARTMENT

Time variations of v.h.f. and u.h.f. signals at short distances

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THE BRITISH BROADCASTING CORPORATION
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RESEARCH DEPARTMENT

TIME VARIATIONS OF V.H.F. AND U.H.F. SIGNALS AT SHORT DISTANCES

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Section	Title	Page
	SUMMARY	1
1.	INTRODUCTION	1
2.	SITES, EQUIPMENT AND ANALYSIS	2
	2.1. Transmitting Site	2
	2.2. Receiving Sites	2
	2.3. Equipment	3
	2.4. Analysis	3
3.	RESULTS	3
	3.1. Comparison of Median Field Strengths	3
	3.2. Range of Signal Variations	6
4.	CONCLUSIONS	8
5.	ACKNOWLEDGEMENTS	9
6.	REFERENCES	9

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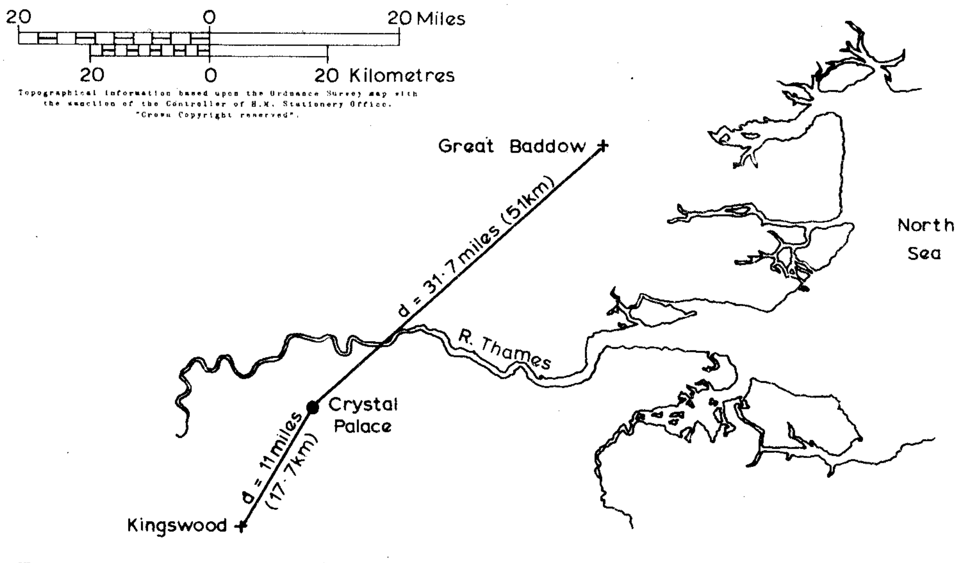
SUMMARY

Field strength measurements of transmissions from Crystal Palace on Channels 1, 34 and 44 were carried out at distances of 11 miles (17·7 km) and 31·7 miles (51·0 km). The results show that the Channel 44 median signals are 3 to 4 dB lower in summer than in winter, presumably due to absorption by foliage. There is no corresponding effect on the Channel 1 signal levels.

During abnormal propagation conditions the received signals at the fringe of the service area are subject to fading, the range of fading increasing with frequency.

1. INTRODUCTION

During the latter part of 1962 and in the spring and early summer of 1963, u.h.f. test transmissions were radiated from the BBC Crystal Palace station on Channels 34 (vision 575·25 Mc/s, sound 581·25 Mc/s) and 44 (vision 655·25 Mc/s, sound 661·25 Mc/s), in addition to the existing v.h.f. television service on Channel 1 (vision 45 Mc/s, sound 41·5 Mc/s). Field strength measurements were made on the sound frequencies of these channels over periods corresponding to the u.h.f. transmitter schedules. The receiving sites were at Kingswood (Surrey) and Great Baddow (Essex). Fig. 1 shows the geographical location of these sites relative to Crystal Palace.



Topographical information based upon the Ordnance Survey map with the sanction of the Controller of H.M. Stationery Office. "Crown Copyright reserved".

Fig. 1 - Geographical distribution of transmitting and receiving sites

● Transmitting Site + Receiving Sites

2. SITES, EQUIPMENT AND ANALYSIS

2.1. Transmitting Site

The Crystal Palace site details and transmission characteristics are given in Table 1.

TABLE 1

Crystal Palace Transmitting Site Details

BAND	CHANNEL NUMBER	FREQUENCY (SOUND) Mc/s	POLARIZATION	SITE HEIGHT a.m.s.l. ft	SITE HEIGHT a.m.s.l. m	AERIAL HEIGHT a.g.l. ft	AERIAL HEIGHT a.g.l. m	LATITUDE	LONGITUDE
I	1	41·5	V	362	110	428	130	51°25' 20"N	00°04' 17"W
IV	34	581·25	H	362	110	653	199	51°25' 20"N	00°04' 17"W
V	44	661·25	H	362	110	693	211	51°25' 20"N	00°04' 17"W

The measurements were normalized for 1 kW effective radiated power (e.r.p.) by using the u.h.f. vision/sound ratios obtained from other measurements within the Crystal Palace service area.[1] The values of 7·5 and 9·0 dB were used for Channels 34 and 44 respectively, as they represent the ratios for 50% of the receiving locations; the nominal ratio is 7·0 dB. These normalization factors do not, of course, affect the conclusions regarding the time variation of any given transmission.

2.2. Receiving Sites

The receiving site details are given in Table 2, and profiles for the transmission paths are shown in Fig. 2. The Great Baddow profile shows that the direct-ray path for the Channel 1 transmissions is obstructed by hills at distances of approximately 20·5 miles (33 km) and 29 miles (46·7 km) from the transmitting aerial. On the other hand, the direct-ray paths for the Channels 34 and 44 transmissions are only partially obstructed at a distance of 29·5 miles (47·5 km) because of the greater height of the transmitting aerials.

TABLE 2

Receiving Site Details

RECEIVER LOCATION	PATH DISTANCE miles	PATH DISTANCE km	SITE HEIGHT a.m.s.l. ft	SITE HEIGHT a.m.s.l. m	AERIAL HEIGHT a.g.l. ft	AERIAL HEIGHT a.g.l. m	TRUE BEARING	LATITUDE	LONGITUDE
Kingswood	11·0	17·7	550	167	30	9·1	214°	51°17' 20"N	00°12' 50"W
Great Baddow	31·7	51·0	115	35	30	9·1	50°	51°42' 21"N	00°30' 16"E

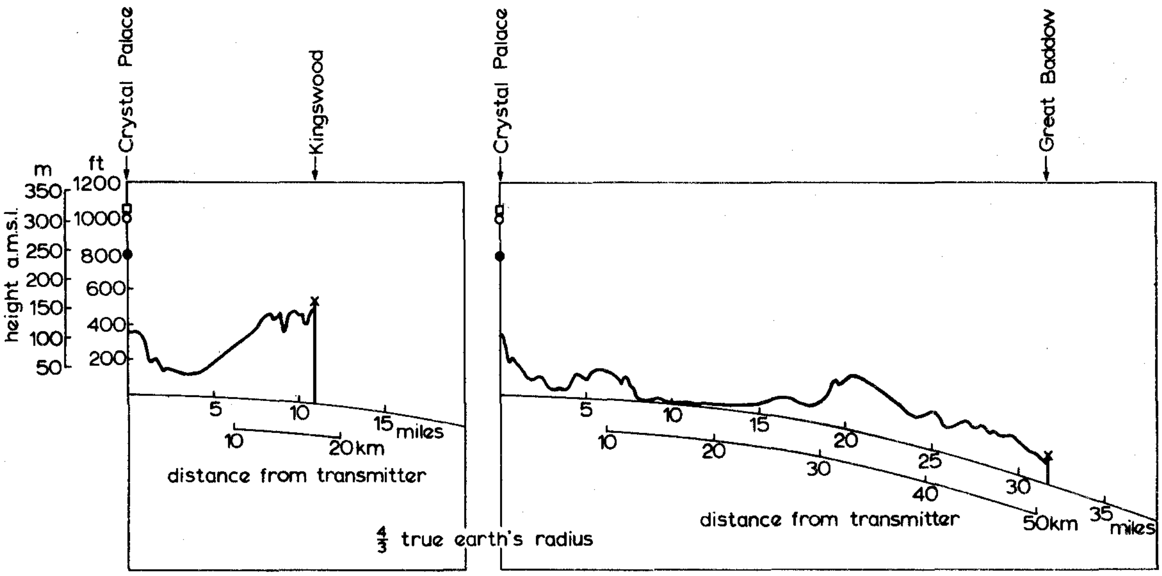


Fig. 2 - Crystal Palace to Kingswood and Crystal Palace to Great Baddow path profiles

● Channel 1 Transmitting Aerial
▫ Channel 44 Transmitting Aerial
○ Channel 34 Transmitting Aerial
× Receiving Aerials

2.3. Equipment

The Bands I, IV and V receivers used for these measurements were designed for use at unattended sites and have been described in BBC Research Department Reports.[2,3,4] The recorder chart speed was 3 in. (7·6 cm) per hour.

Two receiving aerials were used at each of the installations at Kingswood and Great Baddow, a Channel 1 aerial having a gain of 3·5 dB and a wideband Yagi aerial having a gain of 8·5 dB, covering both Channels 34 and 44.

2.4. Analysis

The measurements were analysed to determine the length of time during which the signal levels exceeded various values of field strength. These time durations, expressed as percentages of the overall valid recording time, were then plotted against field strength in decibels relative to 1 μV/m (dB(μV/m)) for an e.r.p. of 1 kW. Separate graphs were prepared for each transmission path, and the number of hours analysed are given against each field-strength/time-percentage curve. On occasions, the e.r.p.s of the u.h.f. transmissions deviated from the nominal values and corrections were made where appropriate.

The results have been separated into two periods, the first from 17th October 1962 to 17th December 1962, and the second from 1st March 1963 to 11th July 1963. There was no Channel 34 transmission during the first period of measurements.

3. RESULTS

3.1. Comparison of Median Field Strengths

The results for the two periods of measurements are plotted in Figs. 3 and 4 as field strength against time-percentage. The field strengths exceeded for selected time-percentages, derived from these figures, are listed in Table 3.

TABLE 3

Crystal Palace Results

CHANNEL NUMBER	RECEIVING SITE	PERIOD OF MEASUREMENTS	FIELD STRENGTH, dB(μV/m), FOR 1 kW e.r.p. 0·1%	1%	10%	50%	90%	99%	99·9%
1	Kingswood	17.10.62 - 17.12.62	66·5	66·0	65·5	65·0	64·5	64·0	64·0
1	Kingswood	1.3.63 - 11.7.63	66·5	66·0	65·5	65·0	64·5	64·0	64·0
34	Kingswood	1.3.63 - 11.7.63	70·5	70·0	69·5	68·5	67·5	67·5	67·0
44	Kingswood	17.10.62 - 17.12.62	70·0	68·5	67·0	66·0	65·0	64·0	64·0
44	Kingswood	1.3.63 - 11.7.63	66·5	66·0	64·5	63·0	61·5	61·5	61·0
1	Great Baddow	17.10.62 - 17.12.62	42·0	41·0	37·0	35·5	35·5	34·5	29·5
1	Great Baddow	1.3.63 - 11.7.63	37·5	37·0	36·0	34·5	32·5	32·0	31·0
34	Great Baddow	1.3.63 - 11.7.63	47·5	45·0	43·0	41·5	39·5	39·0	39·0
44	Great Baddow	17.10.62 - 17.12.62	55·5	53·5	42·5	40·5	39·5	38·5	33·0
44	Great Baddow	1.3.63 - 11.7.63	44·5	41·0	39·5	36·5	35·0	34·5	34·0

Table 3 reveals that the Channel 1 median values at Kingswood were the same for the two periods of measurements; at Great Baddow there was a difference of 1 dB, but this is no greater than the errors of calibration. Larger differences are, however, present in the Channel 44 results. A comparison of the median values during the second period (March-July) shows that reductions of 3·0 dB and 4·0 dB have occurred at Kingswood and Great Baddow respectively. The progressive decrease of signal level at both Kingswood and Great Baddow as the summer months approached suggests that these changes were the result of absorption by foliage. The Kingswood receiving site has a large number of 50 ft (15·2 m) trees in the direction of Crystal Palace. Although there are no trees in the vicinity of the aerial at Great Baddow, it was noted earlier that the transmission path is partially obstructed by the tops of hills, and foliage may also be the reason for the drop in this case also.

In passing, it is worth comparing the ratio of the median field strengths for the different channels, although this was not the primary object of the investigation. The median field strengths of Channels 1 and 44 at each receiving site during the first period (October-December) are shown in Fig. 3. The ratio is 1 dB at Kingswood and 5 dB at Great Baddow; in each case the Channel 44 field strength is the higher. The reason for the smaller difference between the Channels 1 and 44 signals at Kingswood compared with Great Baddow is probably because the Channel 1 path to Great Baddow is completely obstructed, but Channel 44, which uses a higher transmitting aerial, is only slightly obstructed (see Fig. 2). The Kingswood path also shown in the same figure is, however, unobstructed by terrain for both channels. The different ratios for the second period shown in Fig. 4 are accounted for by the previously-mentioned absorption by foliage.

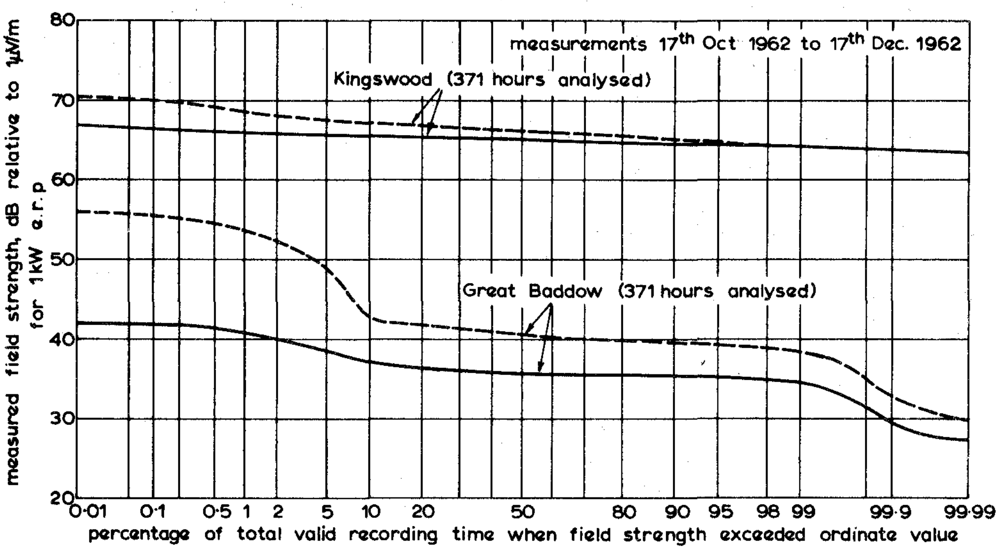


Fig. 3 - Variation of field strength with time (17th October 1962 to 17th December 1962)

——— Channel 1 — — — Channel 44

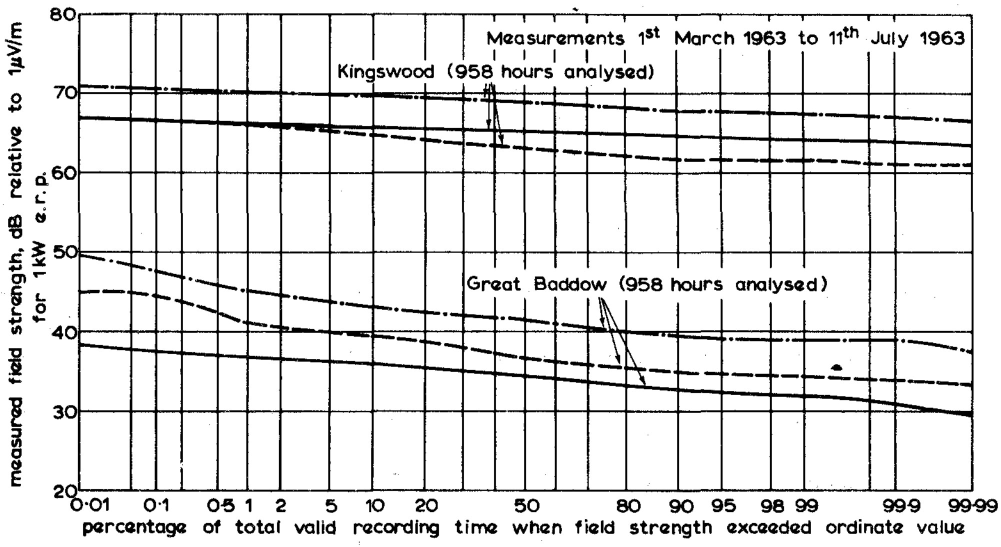


Fig. 4 - Variation of field strength with time (1st March 1963 to 11th July 1963)

——— Channel 1 —·— Channel 34 — — — Channel 44

Another comparison of median values may be made. Fig. 4 shows that the ratios of the field strengths of Channels 34 and 44 at Kingswood and Great Baddow are 5·5 dB and 5·0 dB respectively. This somewhat high ratio may be due in part to the uncertainty regarding the performance of the Channel 44 transmitting aerial.

3.2. Range of Signal Variations

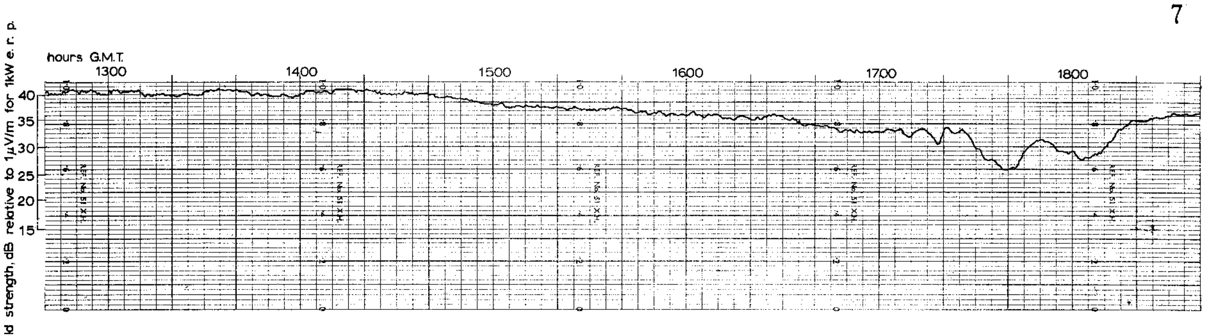
In interpreting the recorder charts it should be remembered that during normal propagation conditions the field strengths are symmetrically distributed about the median value; the slope of the distribution for the short ranges considered here is, in fact, small. During abnormal conditions the signal is usually enhanced rather than reduced. These abnormal conditions last for too short a time to affect the median value but are reflected in the greater fading range shown in Table 4 for the 0·1 to 50 time-percentages, compared with that for the 50 to 99·9 time-percentages. It is also evident from Table 4 that the range of fading is greater for the October-December period than for the March-July period. Intense abnormal propagation conditions that occurred during the first two weeks in December 1962 account for the difference. Two further characteristics of the fading may be noted in the table; fading range is greater at the more distant site for all channels, and in general increases with frequency at both sites.

TABLE 4

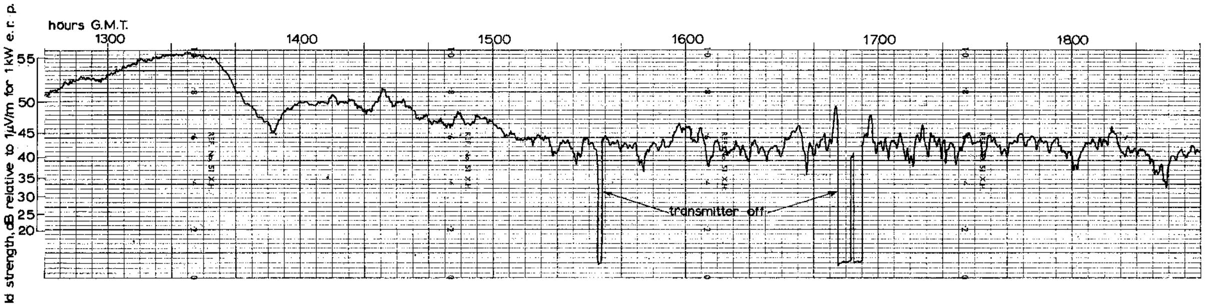
Range of Fading

CHANNEL NUMBER	RECEIVING SITE	PERIOD OF MEASUREMENTS	DISTANCE (km)	RANGE OF FADING FOR VARIOUS TIME-PERCENTAGES (dB) 0·1% TO 50%	50% TO 99·9%
1	Kingswood	17.10.62 - 17.12.62	17·7	1·5	1·0
1	Kingswood	1.3.63 - 11.7.63	17·7	1·5	1·0
34	Kingswood	1.3.63 - 11.7.63	17·7	2·0	1·5
44	Kingswood	17.10.62 - 17.12.62	17·7	4·0	2·0
44	Kingswood	1.3.63 - 11.7.63	17·7	3·5	2·0
1	Great Baddow	17.10.62 - 17.12.62	51·0	6·5	6·0
1	Great Baddow	1.3.63 - 11.7.63	51·0	3·0	3·5
34	Great Baddow	1.3.63 - 11.7.63	51·0	6·0	2·5
44	Great Baddow	17.10.62 - 17.12.62	51·0	15·0	7·5
44	Great Baddow	1.3.63 - 11.7.63	51·0	8·0	2·5

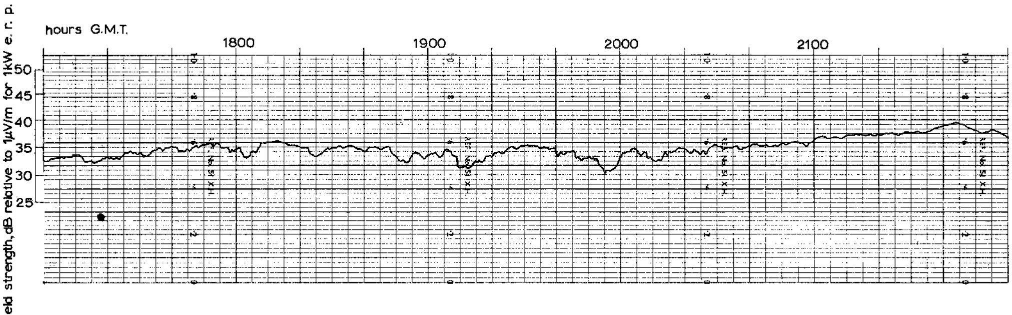
Fig. 5 shows selected samples of records made over a few hours at Great Baddow, to illustrate the degree of fading which can occur at the fringe of a service



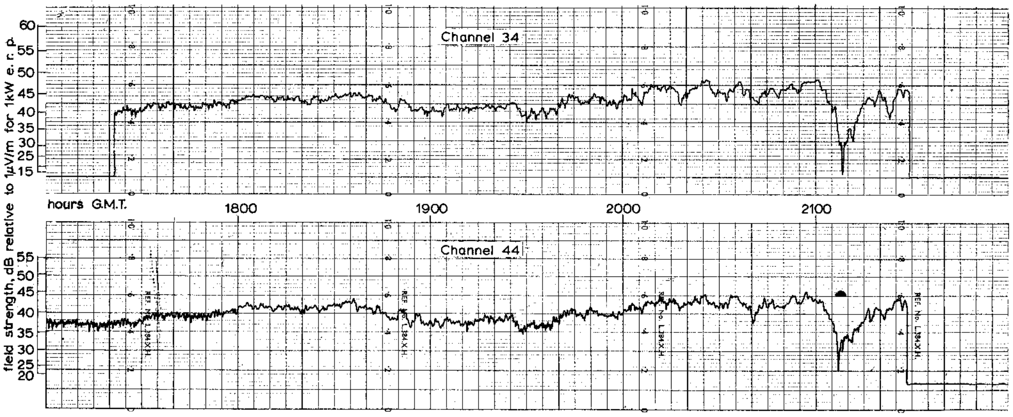
(*a*) Channel 1, 6th. December 1962



(*b*) Channel 44, 6th. December 1962



(*c*) Channel 1, 7th.June 1963



(*d*) Channels 34 and 44, 7th.June 1963

Fig. 5 - Selected recorder charts of Crystal Palace transmissions received at Great Baddow

area. The two dates involved are 6th December 1962 and 7th June 1963. On 6th December 1962 a dominant anticyclone was situated over Central Europe and extended over southern England. The anticyclone on 7th June 1963 was centred off the coast of Norway and extended over the United Kingdom. The maximum and minimum field strengths obtained from Fig. 5 are listed in Table 5, together with the appropriate overall median signal for 17th October 1962 to 17th December 1962 and 1st March 1963 to 11th July 1963. This table shows the variation of signal level about the median value from measurements taken over the whole period. Attention may be drawn to a point of interest in Fig. 5(*d*). The near drop-out of signals which occurred at approximately 21.07 hours on the Channels 34 and 44 charts shows a displacement in time of one minute. This means that the fading which occurs on one channel may not necessarily occur at the same time on the other co-sited transmission.

TABLE 5

Variation of Field Strengths

Great Baddow Sample Charts (Fig. 5)

FIG. 5 CHART	CHANNEL NUMBER	MEDIAN FIELD STRENGTH FOR APPROPRIATE OVERALL PERIOD (dB)	MAXIMUM SIGNAL (dB)	MINIMUM SIGNAL (dB)
(a)	1	35·5	41·5	26·0
(b)	44	40·5	55·5	32·5
(c)	1	34·5	39·5	30·5
(d)	34	41·5	49·0	15·0
(d)	44	36·5	45·0	22·5

It is evident from the range of fading given in Table 4 and from the sample charts of Fig. 5 that wide signal variations are possible at the fringe of a v.h.f. or u.h.f. service area. The signal variations are greater for the u.h.f. than for the v.h.f. channels and they are prevalent during anticyclonic weather. As is well known, survey measurements at the fringe of the service area of a high-power television transmitter are therefore likely to give misleading results during anticyclonic weather.

4. CONCLUSIONS

The Channel 44 median field strengths received at Kingswood and Great Baddow are respectively 3 dB and 4 dB lower for the period 1st March 1963 to 11th July 1963 when compared with the measurements for the period 17th October 1962 to 17th December 1962. The lower overall field strengths for the spring and early summer months in 1963 may be attributed to foliage. This effect is not present on the Channel 1 transmission.

The u.h.f. signals are subject to greater variations than the v.h.f. signals; the fading occurs during anticyclonic weather conditions, the range of fading being more severe at the fringe of the television service area. The v.h.f. and u.h.f. range of fading for the 0·1 to 50 time-percentages is 1·5 to 6·5 dB and 2 to 15 dB respectively. The corresponding figures for the 50 to 99·9 time-percentages are 1 to 6 dB and 1·5 to 7·5 dB.

5. ACKNOWLEDGEMENTS

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The BBC Research Department staff concerned with the installation and maintenance of the apparatus and also with the analysis of the measurements are Messrs. S.J. Ashdown and I. Rhodes, and Mrs. S. Dampney.

6. REFERENCES

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